

Павел Петрович Попельский

**Проекты
сдвоенных
самолетов-
катамаранов
будущего
1950-х - 1990-х годов
XX века
США и СССР**

**По публикациям
старых журналов**

**Павел Петрович
Попельский**

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The Grand Alliance

THE sixteenth of December, 1959, was a day that will go down in British aeronautical history as one of tremendous events; and, as on the eve of some other climatic occasions, it happened that there was a sound of revelry by night—a dinner at the Royal Aero Club; a celebration by the British Air Line Pilots' Association; a welcome for a new Boeing representative in London. At all these functions the talk was variously stimulated or vitiated by rumour and speculation concerning the Hawker Siddeley/de Havilland merger. There were many who received the news with dazed incredulity—incredulity that the legendary "D.H.s." of the faithful Nine Ack, the peerless Mosquito, and the transcendent Comet had surrendered their independence. And there was much sorrow on that account. But comfort was drawn from the thought that the D.H. banner would continue to be borne forward within the mighty new alliance, as are those of Hawker and Avro, Armstrong Whitworth, Blackburn and Folland. And as with names, so will it be with teams. A degree of rationalization is to be expected—indeed to be wished; and Sir Roy Dobson, managing director of the Hawker Siddeley Group, proposes to take a long and careful look at the mighty new fusion of power to see how this can best be accomplished. What cannot be accomplished, unhappily, is the securing of orders that were not there before.

Sir Roy, of course, is the commanding figure in this historic scene. "All this is in keeping with the desires of the Minister of Aviation," he declares, as though to the nation at large; adding, as in an aside by a general for the reassurance of his troops, "But you can take it we would not have bid for de Havilland unless we saw advantages in it." Sir Roy and de Havilland chairman Sir Aubrey Burke were not slow to proclaim their new grand alliance as the most powerful of its kind in the British Commonwealth; adding that the two companies were already well known to each other, and that the integration of their business interests and technical staffs could be readily effected to the substantial benefit of both.

Balance of Power

The Aviation Minister has, up to this writing, made no utterance concerning the new dispositions of power. If we are to believe one commentator, the HS/DH join-up may not be entirely what he wished to bring about (the wrong factions having consorted); while from another observer we have the benevolent assurance that Mr. Sandys could enjoy his Christmas in the knowledge that he has accomplished the essence of his task. In any case, it is significant that the first overtures came from de Havilland and not from the Group.

Further convulsive changes in the industry's deployment will yet be needed to redress the balance of power. As this is written, Vickers-Armstrongs and English Electric—both commanding big battalions—still stand uncommitted, though holding common ground with the TSR.2. Short & Harland, Handley Page and the aircraft side of Bristol—these and other forces of illustrious achievement are likewise unaligned. In particular there is much conjecture concerning the future affiliations of Fairey and Hunting, already engaged with de Havilland, as the Aircraft Manufacturing Company, on the D.H.121. The two great engine camps stand ranged as Rolls-Royce and Bristol Siddeley.

This, then, is the British order of battle as at present seen—still re-forming, but all the time strengthening in resources and, we believe, in purpose also. The immediate effect of this newest great alliance was to create a strong demand for most aircraft shares on the Stock Exchange—which is one tangible endorsement of the Sandys plan for massive rationalization.

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TOMORROW'S AERO ENGINES

A Valuable Exposition of Bristol Siddeley's Thinking

THE James Clayton lecture for 1959 was delivered by Dr. S. G. Hooker, OBE, RSC, D Phil, technical director, Aero, of Bristol Siddeley Engines, to the Institution of Mechanical Engineers on December 16. He chose as his title "The Future of Air-breathing Engines in Aviation." As is well known, he said, the 1957 White Paper on Defence saw little future use for manned aircraft and placed the whole emphasis on ballistic missiles as a deterrent and guided missiles for defence. Yet [the lecturer continued] there is still a great deal to do. This country has an opportunity to enter the medium jet airliner field and provide a so-called Viscount replacement. Nor does the future for manned aircraft seem entirely negative, approval for a tactical/strike and reconnaissance aircraft for the RAF having been given this year.

In the last 20 years the thrust of jet engines has increased twenty-fold. It is not expected that this trend will continue, because engines giving 20,000lb thrust are suitable for four-engine aircraft up to about 550,000lb gross weight, which can operate economically over the longest ranges and therefore there is little incentive to go to a larger machine.

On the other hand, supersonic military aircraft may require reheat, which can give a thrust of over 30,000lb from an engine of the Olympus type. At an altitude of 36,000ft an engine of this size without reheat will develop about 9,000 thrust horsepower at M1 and 29,000 thrust horsepower at M2, with specific fuel consumptions of 0.55 and 0.45lb/l.h.p./hr respectively, representing an overall thermal efficiency of about 30 per cent. With reheat the same engine develops the colossal power of 100,000 thrust horsepower at M2.2 with a specific fuel consumption of 0.625lb/l.h.p./hr.

Improvement in Specific Fuel Consumption. In parallel with the increase in thrust, there has been a reduction in specific fuel consumption. Until 1946 most turbojets, being derived from the original Whittle conception, had single-stage centrifugal compressors; these limited the compression ratio to around 4:1, and the specific consumption was in excess of 1.0lb/lb/hr (Fig. 1).

Then came the Avon and Sapphire engines with single-spool axial compressors giving some 7:1 compression ratio and a higher efficiency, resulting in a consumption of 0.8 to 0.9lb/lb/hr. In the early 1950s the two-spool axial compressor engine emerged,

in the form of the Bristol Olympus, enabling compression ratios in the range 10:1 to 15:1 to be achieved, and consumptions between 0.8 and 0.7 were obtained (in fact, an Olympus on test in 1958 gave an s.f.c. of 0.68lb/lb/hr).

Concurrently the Rolls-Royce Conway appeared, embodying not only a two-spool compressor but also a by-pass of air from the low-pressure compressor round the engine and mixing with the main flow in the jetpipe. This arrangement reduces mean jet velocity and temperature and results in an improvement in the propulsive efficiency; and consumptions below 0.7lb/lb/hr were the by-product of by-passed in the case of the Conway and obtained. The quantity of air by-passed in the case of the Conway is by no means the optimum (it is being substantially increased—Ed.) and a later design, the Bristol Siddeley BE.58, with three times as great a proportion of air by-passed will give a specific consumption of less than 0.6lb/lb/hr. By raising the compression ratio, a consumption of less than 0.5lb/lb/hr can be foreseen. Such an engine is a real ducted-fan engine, and development of this type will form the main effort of most aero-engine companies in the 1960 era. The large boost in thrust which can be obtained by afterburning in the fan stream will render these units attractive at both subsonic and supersonic speeds.

Increase in Thrust/weight Ratio. In the early 1940s the thrust/weight ratio of the centrifugal engine was rather less than 2.0lb thrust/lb weight. With the Avon, Viper, Olympus and Conway, this figure has now risen to over 4lb thrust/lb weight, and with the Orpheus a thrust/weight ratio of over 6 was achieved.

For military purposes, aircraft capable of very short or vertical take-off are desirable, and this particular problem is at present receiving great attention. The type of powerplant which would be suitable for such an application is the Bristol Siddeley BE.53 ducted-fan lift/thrust engine (similar to Fig. 2), which has a high thrust/weight ratio. If specialized engines used only for lifting purposes at take-off and landing are considered, then modern designs indicate that thrust/weight ratios of the order of 14 can be achieved. Such units would be ducted-fan engines of low compression ratio, a type in which Bristol Siddeley is actively interested (Fig. 3).

Vertical Take-off Aircraft. Broadly, such developments can be considered in two classes: single-seater aircraft and larger types. The single-seater would be of single-engine configuration, the powerplant being capable of the combined duty of both lifting the aircraft at take-off and landing, and propelling it in normal flight. Such an engine is shown in Fig. 2. The jet is deflected either downward to give vertical lift or in any inclined position up to the horizontal in order to give a combination of lift and thrust. The airflow from the ducted fan at the front is bifurcated into two ducts, one on each side of the engine, as is the exhaust jet. These then terminate in directional control nozzles.

An engine of this type has many advantages of a very practical nature:

It can be mounted in the aircraft fuselage in the conventional manner.

The jets can always be directed rearwards for conventional runway take-off and landing.

The engine can be tested and the aircraft taxied with the jets directed rearwards avoiding problems of ground erosion and debris.

For short take-offs, the aircraft can be accelerated with the jets directed rearwards and then the nozzles can be deflected downwards giving a combination of lift and thrust. In this way the aircraft will sweep its debris behind it away from the intake.

Even for a true vertical take-off, the engine can first be opened up to full power and then the nozzles rapidly turned downwards to give the minimum time for erosion and scattering debris.

Combining lift and thrust in one engine, the logistic and maintenance problems are reduced to a minimum.

For transport aircraft multiple powerplants are needed. Since the main problem is to obtain a thrust equal to the aircraft's weight, it follows that all engines should be capable of giving their full power in the form of lift. In other words, engines used solely for propulsion are undesirable. Once in normal flight most of the engines can be shut down, since the cruising thrust required is perhaps one-tenth of the weight of the aircraft. The engines which will be shut down during cruise and only be used for take-off and landing must be specialized lift engines and have minimum weight. An engine of this type is shown in Fig. 3.

Let us consider a transport aircraft (Fig. 4) with two BE.53 lift/thrust engines, one under each wing, and four specialized lift engines installed in the fuselage. If the thrust of the former is 15,000lb and that of the latter 10,000lb, then the total installed thrust is 70,000lb. To provide for the possibility of an engine out, the weight of the aircraft for vertical take-off must not exceed

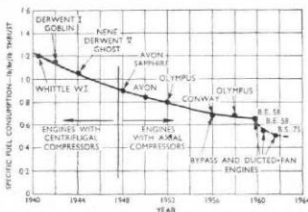
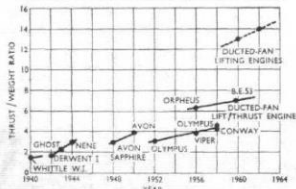


Fig. 1. Progressive improvement in turbojets: decrease in s.f.c. and increase in thrust/weight ratio, both plotted for sea-level static conditions; the s.f.c. of the new BE.58 fan is startling



TOMORROW'S AERO ENGINES . . .

able and more economical jet aircraft, powered by ducted-fan engines. It must be reaffirmed that a modern jet aircraft is more economical, and will lead to lower fares than the slower propeller-driven machines.

Suitable engines for these airliners are not yet available and a great opportunity faces the British aircraft industry in this field. It must be emphasised that Government support—either in a direct development contribution or in orders for the RAF—is essential to make the commercial risk justifiable. The prize is big, though it is unlikely that the history of the Viscount will be repeated, for in that case competition was virtually absent.

The two greatest engine companies in the USA are already offering ducted-fan engines, a type which is certain to take over from the straight jet in the next decade. If we wish to stay in the race, the correct technical choice of both aircraft and engines must be made, and we must apply all our effort in this direction.

Engines for Supersonic Flight. For engines designed for supersonic flight, perhaps the most significant factor is the high air pressure generated by the forward speed alone. At M2, a pressure ratio of 6:1 can be obtained from a suitable air intake, and this increases to more than 20:1 at M3. Compression ratios of this order are sufficient to eliminate the necessity for the compressor and turbine, resulting in the concept of the ramjet. At approximately M2.6, the ramjet would have a similar specific consumption to a modern turbine engine of 12:1 pressure ratio; and above this speed the ramjet is superior.

This is amply demonstrated by plotting specific fuel consumptions of turbojets and ramjets at varying Mach numbers. Additionally, one can examine the specific consumption of a combined turbojet/ramjet unit, since it is necessary to provide an auxiliary means of accelerating the aircraft up to speed.

A more detailed examination of a transport aircraft (Fig. 7), capable of cruising at 2,000 m.p.h. with a transatlantic range, shows the chief advantage which a combination of ramjet and turbojet engines has over a similar machine powered solely by turbojets is the saving in weight which the ramjets offer. The aircraft with combination engines has a payload of 8.6 per cent of the gross weight, and that with turbojets only 4 per cent. The difference is almost entirely due to the difference in engine weight. With an aircraft of, say, 350,000lb (a trifle more than the Boeing 707 Intercontinental) a useful payload of 30,000lb can be obtained with an aircraft having a combination of ramjet and turbojet engines, with a cruising speed of 2,000 m.p.h. and a still-air range of 4,000 n.m.

Ramjets have so far been used only for missile propulsion, but their light weight, simplicity and inherent reliability must bring them more and more into the picture as the speed of transport aircraft increases—as it assuredly will—to three or four times the speed of sound. It is incidentally worth noting that, because of the vast airflow required to propel an airliner at M3 at 70,000ft, the size of intake ducts leads to a configuration (Fig. 7) with ample space for fuel and payload.

Flight at Hypersonic Speeds. So far we have reached 2,000 m.p.h. and 100,000ft, and to go further the ramjet is the only

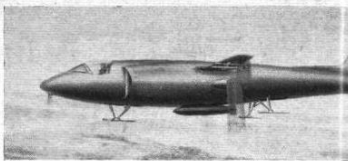


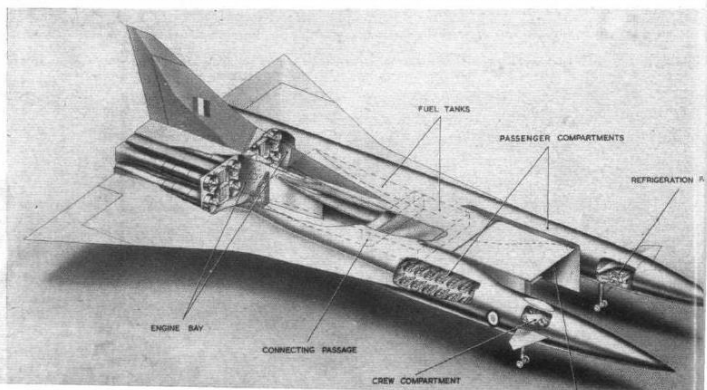
Fig. 6. Bearing a superficial resemblance to the Hawker P.1127, this VTOL strike machine is supported at full speed by tiny wings

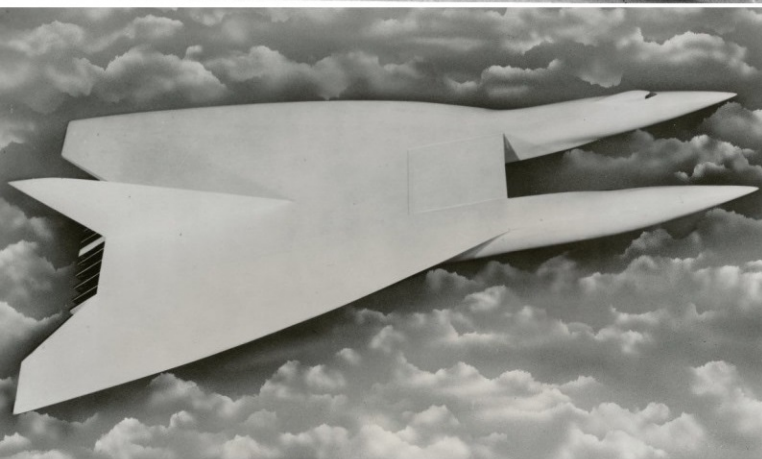
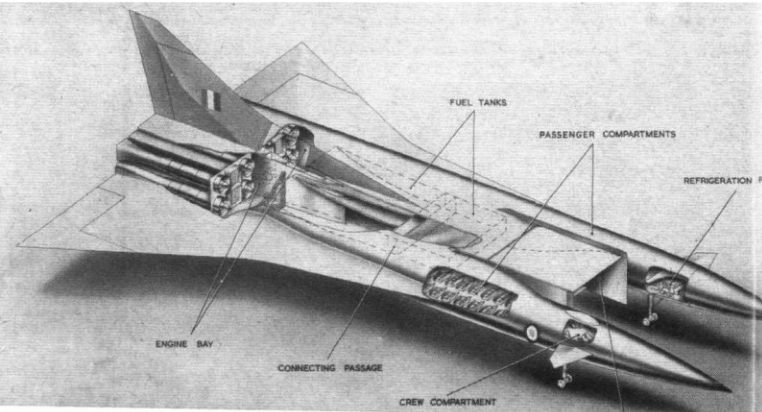
possible propulsion unit. In the hypersonic flight region (i.e., above about 3,000kt or M5.0) there is a broadly defined corridor in which normal flight should be possible. This corridor is bounded on the one hand by an aerodynamic limitation, where at very high altitudes the air pressure developed by the forward speed is insufficient to maintain flight, and by a skin temperature limitation on the other hand defining the speed above which the temperature of the aircraft skin will be too high for structural materials—say, 1,200° K. If we restrict our consideration to speeds up to 5,000 m.p.h., then suitable flight altitudes lie between 100,000 and 200,000ft.

A ramjet engine designed for internal supersonic combustion has a converging passage forming a supersonic diffuser in which air is compressed, fuel being injected just upstream of the throat. The fuel readily ignites because the air temperature due to compression will be several thousand degrees Kelvin. Downstream the combustion is stabilized by a standing detonation-wave in the supersonic flow which occurs in the diverging nozzle. This type of engine suffers from the difficulty that its internal surfaces are exposed to very high temperatures. An interesting suggestion to alleviate the problem of skin temperature is for an external hypersonic ramjet, in which the air is compressed by the curved undersurface and the fuel is injected so that combustion takes place adjacent to a downward- and rearward-facing surface, thus providing lift and thrust.

The overall thermal efficiency which might be expected from an air-breathing engine varies from some 40 per cent at M2 through a figure of nearly 60 per cent at M4, to a peak of over 65 per cent at M7. This increase in overall thermal efficiency with rise in Mach number tends to offset the fall in aircraft lift/drag ratio which occurs during passage through the transonic region. As a result, the range which may be obtained from a family of aircraft, all using the same percentage of fuel during flight and designed to have the best L/D ratio appropriate to their cruising Mach number, has a maximum at M0.8, falls rather sharply to a minimum at M1.5 and then rises steadily as the Mach number increases to over M5. This indicates that the speed range between M1 and M2 should be avoided, and justifies looking to a speed in excess of M2 for the first supersonic airliner.

Fig. 7. Dr. Hooker presented this supersonic airliner as a promising configuration; such transports were described in our issue of June 19 last





<https://www.flickr.com/photos/apollo4ever/52187126096/>

B-SE (twinfus jet) v. bw o. n (ca. 1959, unnumbered Bristol-Siddeley Engines Ltd. promo photo)

SUPERSONIC GIANT Capable of flying 130 passengers from London to New York in 98 minutes, and from New York to Los Angeles in 70 minutes, the airliner shown in model form... would be powered by a combination of eight or more turbojet engines, such as used on conventional jet planes, and ramjets, now used to power missiles. Dr. Robin R. Jamison, head of the Ramjet Department at Bristol-Siddeley Engines, British aviation firm that conceived of the plane, said the delta-wing craft could be produced with today's engineering know-how. A specification for a long-range, supersonic airliner, capable of carrying 130 passengers over stage lengths of 3,500 miles at three times the speed of sound at 12.4 cents (10.6 pence) for short ton statute mile - was outlined by Dr. Robin R. Jamison, Asst. Chief Engineer of Bristol Siddeley Engines Ltd. and head of the Ramjet Department - in a paper delivered at the Institute of Aeronautical Sciences, summer meeting in Los Angeles on June 18th. The power plant of the new machine would be a combination of ramjets and turbojets, integrated into a delta-wing airframe. This combination is said to be suitable for development for use at speeds up to Mach 4 or 5.

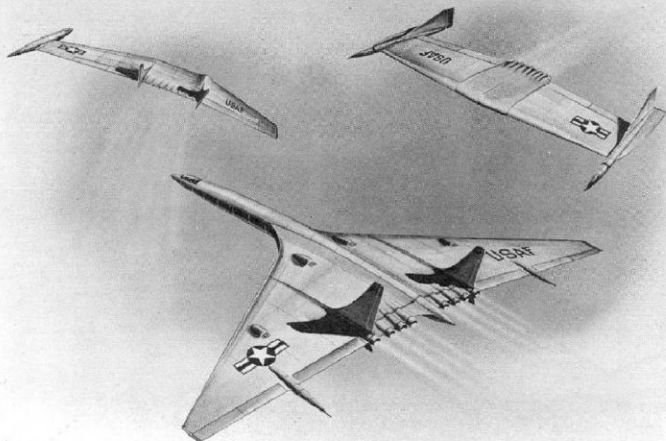


FIG. 12

1956-01-01

NUCLEAR POWER IN THE AIR OF TOMORROW 560272

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Citation: OHLINGER, L., "NUCLEAR POWER IN THE AIR OF TOMORROW," SAE Technical Paper 560272, 1956, <https://doi.org/10.4271/560272>.

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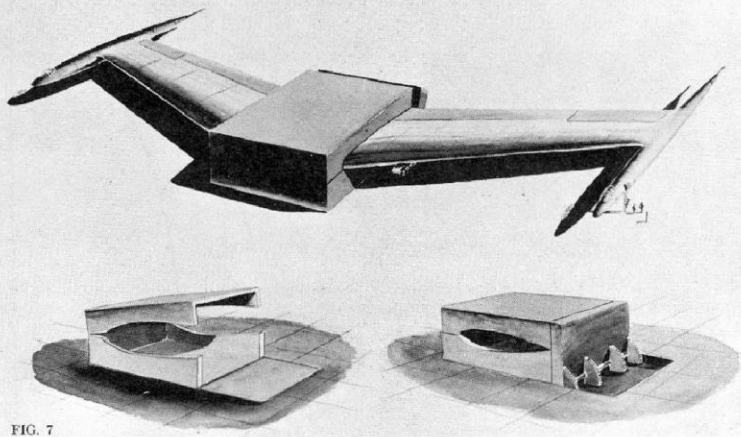


FIG. 7

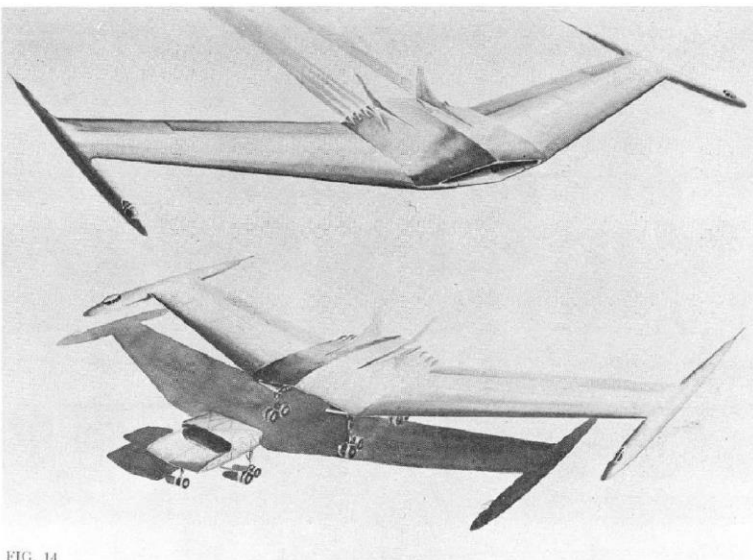


FIG. 14



Цвет и жизнь

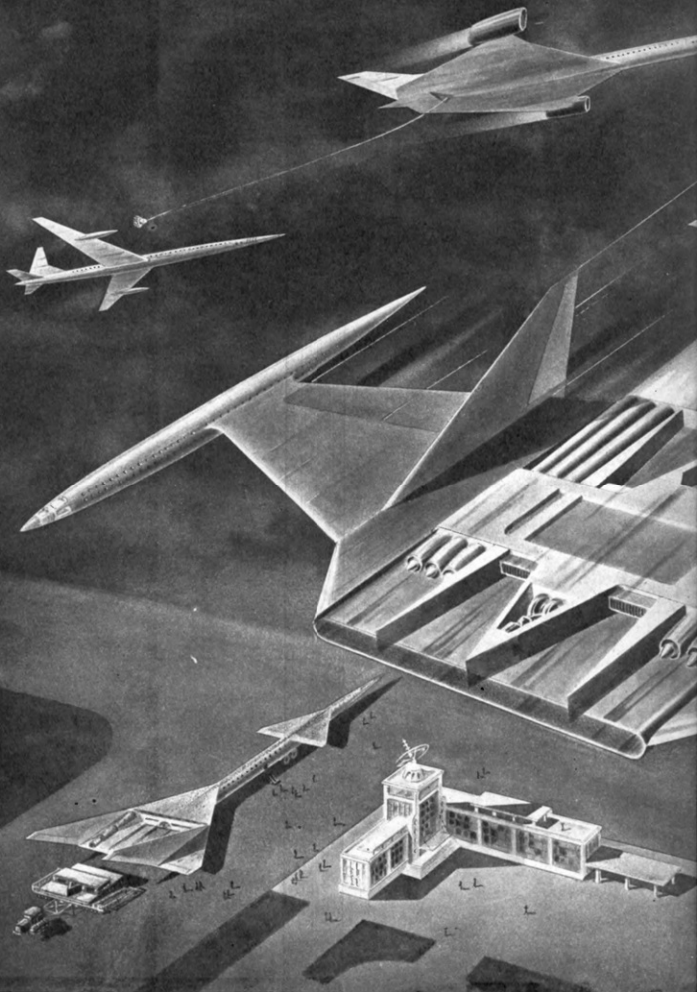


СТУДЕНЧ
НОМЕ

Пролетарии всех стран, соединяйтесь!

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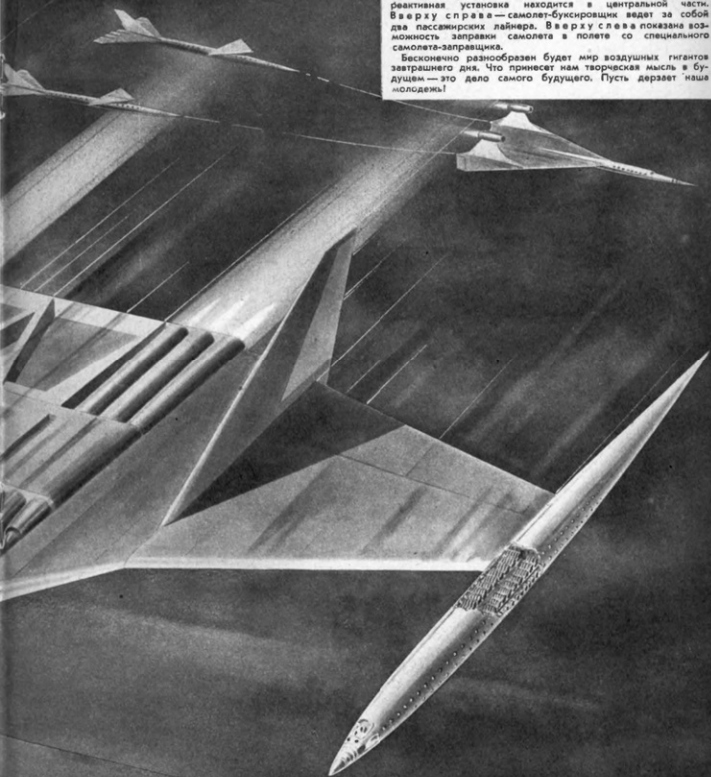
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производственно-технический
и научный журнал ЦН ВЛКСМ
28-й год издания



СТУДЕНЧЕСКИЙ ПРОЕКТ

«Накими могут быть самолеты завтрашнего дня?» Этот вопрос волнует нашу молодежь. Мы обратились к художнику С. Наумову, к студенту МГУ А. Жигареву и инженеру Д. Пипко с просьбой набросать хотя бы отдаленные контуры самолетов будущего. На рисунке вы видите несколько типов воздушных гигантов. В центре — самолет, пассажирские кабины которого вынесены на концы крыльев, а силовая реактивная установка находится в центральной части. Вверху справа — самолет-буксировщик ведет за собой два пассажирских лайнера. Вверху слева показана возможность заправки самолета в полете со специального самолета-заправщика.

Бесконечно разнообразен будет мир воздушных гигантов завтрашнего дня. Что принесет нам творческая мысль в будущем — это дело самого будущего. Пусть дерзает наша молодежь!





ТЕХНИКА-7
МОЛОДЕЖИ 1971

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РЕАКТИВНЫЕ ТРЕЗУБЦЫ ПЯТОГО ОКЕАНА

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Б. ШИРЕНДЫЕ,
президент
Академии наук МНР

На серых песках —
Караган и полынь,
Ни капли воды в каменной
 утробе —
Пальцам дыханием полупустынь
Пахнули в лицо мне
Бескрайние Гоби.
Оттиснут на скалах пустынный
 загар.
Дзерены — олени, как тени
 миража,

Стихотворение номера

ГОБИ ПУСТЫНЯ

Скользят вдалеке.
Круторогий архар
Застыл на уступе скалистого
 кряжа.
Куда ты воззрился?
К далеким горам.
Туда, где в извечной погоне,
 а разгоне,
Вослед огнекрылым шальным
 скакунам
Несутся куланы — небесные кони.

●
На припек греются
Ящеры юркие,
А под ними стелются
Отложенья юрские:
Красные, зеленые,
Скальные, сыпучие —
В зры отдаленные
Были тут дремучие
Чащи непролазные
Да болота темные,
И бродили страшные
Ящеры огромные.
Их палеонтологи
Ищут, как сокровища...
Спят в песчаном пологе
Ящеры-чудовища.
А на солнце греются
Ящеры юркие,
А под ними стелются
Отложенья юрские.

Перевел с монгольского
В. Тихомиров

«Нужно вообразить миллион неправильностей»

К 4-й странице обложки

Г. ПОКРОВСКИЙ,
доктор технических наук, профессор
Рисунки автора

Сверхзвуковой самолет с могучими стреловидными крыльями... Знакомый всем образ. Машина напоминает птицу, и, кажется, лучшей формы для стремительного движения не подобрать. Но там, где речь идет о колоссальных скоростях, аналогии с «механизмами» природы нередко могут только скрывать творческую фантазию. Поэтому забудем птиц и поразмыслим о лайнере с обратной стреловидностью крыльев.

Во время полета быстрее звука около крыльев возникают ударные волны (скачки уплотнения). На схеме показано, что линии ударных волн подходят как раз к воздухоприемникам турбореактивных двигателей. Создать в этих местах повышенную плотность воздуха и тем самым улучшить питание двигателей — вот для чего понадобилась обратная стреловидность. Самолеты нового типа смогут подниматься заметно выше нынешних, а затраты энергии в турбокомпрессорах будут меньше.

Предложенное решение — не единственное. Можно представить себе самолет с двумя высокими килем, между которыми установлены две плоскости и группа турбореактивных двигателей. Возникнет ударная волна, идущая от первой плоскости ко второй. Отражаясь от преграды, волна усилится и подойдет к воздухоприемникам двигателей. И это средство окажется подходящим для достижения цели: увеличить потолок, а тем самым и скорость полета.

Возможно, наша идея покажется кому-нибудь технической ересью или даже абсурдом. Но скептикам не мешало бы помнить афоризм Оскара Уайльда: «Чтобы узнать истину, нужно вообразить миллион неправильностей».

КРАСНЫЙ БОГАТЫРЬ ЗЕЛЕННЫХ ГОР (окончание)

До революции в Монголии не было своей интеллигенции, не было искусства, культуры. Профессиональные и самодеятельные театры, процветающая литература, киностудии — живые доказательства плодотворности социалистического развития.

Нерасторжима многолетняя дружба советского и монгольского народов. Ее скрепляет даже космос. С помощью трансляционной станции «Орбита» араты смотрят сегодня через телеспутник московские передачи.

В годы войны против немецкого фашизма и японского империализма монгольский народ проявил себя героически. Еще во время военного конфликта на Халхин-Голе монгольские воины выступали плечом к плечу с советскими солдатами. Герой монгольского народа Л. Дандар десятки раз поднимал в атаку монгольские подразделения. Сегодня этого легендарного человека называют «монгольским Чапаев».

Революционный союз молодежи был создан в 1921 году под руководством Чойбалсана. Монгольский комсомол отдает все силы

строительству новой жизни. Молодежные фестивали советско-монгольской дружбы стали традиционными. Молодежь крепит интернациональные связи с социалистическими странами и в первую очередь с советскими юношами и девушками.

Город Дархан построен интернациональными бригадами молодежи. Это почти символ. Социалистические страны дружно помогают Монголии в строительстве новой жизни. Здесь можно встретить инженеров и рабочих из Болгарии и Польши, из Чехословакии и ГДР. И конечно, из нашей страны.

«Работать и жить по-социалистически» — вот лозунг, по которому живут сейчас молодые строители Монголии.

Недавно прошедший XVI съезд Монгольской народно-революционной партии наметил новые перспективы развития социалистической Монголии. В дни 50-летия хочется пожелать Монгольской Народной Республике процветания и новых успехов.



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BEACHHEAD FLYING BOAT
Page 133



GIANT twin-hull flying boats, weighing 250 tons or more, may be the amphibious craft for beach landings on hostile shores in future wars. Such huge seaplanes could carry 1000 men plus equipment, would fly at speeds approaching the top speeds of the fastest land aircraft, and upon approaching a hostile shore would land in the water, taxi up to the beach and open armored bow doors to discharge their troops.

If submarines make the seas too dangerous for ordinary shipping, the twin-hull flying boats envisioned above will have to be built, says Ernest G. Stout, head of naval aircraft research for the Consolidated-Vultee Aircraft Corporation. In fact, he says, the aircraft industry could start construction of them at any time that the need arises. All major problems in large flying-boat construction have already been given study.

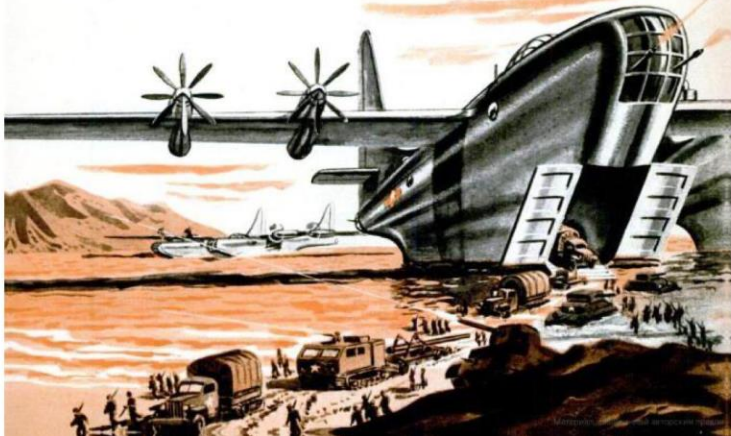
Flying-boat research was practically abandoned during the last war because of the emphasis on land planes. Since then designers have



from MODEL to MONSTER

By Ewart Thomas

Research for aerial assault boats that will carry up to 1000 men is being carried on with flying miniatures weighing as little as 123 pounds. Above and below are an artist's idea of how tomorrow's 250-ton amphibians will "hit the beach."



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New-technology monster transports

will dwarf today's
jumbo jets

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New-technology monster transports

will dwarf today's jumbo jets

By BEN KOCIVAR

Seated in the cockpit of Pan American's new Lockheed L-1011-500 Tri-star, I could look out over the 164-foot-long wings and see huge Boeing 747's and McDonnell Douglas DC-10's trundling along the runways of New York's JFK International Airport. Despite the many trips I've made in them, they still seem too big to get airborne. But they do. And even bigger flying machines are on the way.

Today, I was getting a preview of new material, design, and gadgetry used in the L-1011-500 that could lead to airplanes two, three, even four times its size after the 1990's. As you can see from the pictures, these idea planes are startling departures from today's designs. All are products of joint Air Force/NASA/industry investigations aimed at giant civil-military transports. But just as the Air Force/Lockheed C-5-A technology led to today's jumbo jets, these concepts will

likely lead to super-size passenger airliners in the decades to come.

Is bigger better?

NASA and military planners think so. First, we need to carry bigger, bulkier military loads quickly over greater distances. And second, bigger planes could move more for less money, a critical concern for all users.

To be efficient, these future behemoths will need to be as light as possible. Captain John Harris, Pan Am's check pilot for the new Lockheed jumbo, explained some of its innovations that point the way.

"First, nine feet was added to the wingspan, giving a higher-aspect-ratio wing, which gives more lift with less drag," he explains. "Normally, that would require a beefed-up structure, which would add weight. Instead, this jumbo has active controls—computer-actuated ailerons. These not only control banking, but also move in unison, almost continuously,

to spoil or add lift on the wing tips. This cancels any extra aerodynamic load on the wing." Result: You don't have to beef up the structure.

Lockheed and others are extending the active-control concept to flaps, elevators, and rudders. They would be smaller, lighter, and create less drag. Active controls also reduce aerodynamic loads on the fuselage, so it too can be lighter.

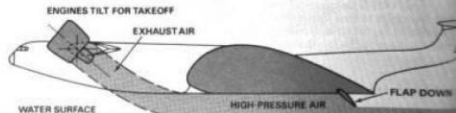
The L-1011-500 has many parts made of composites; they are 25 percent lighter than metal parts. Future monsters would use even more composites. Less weight and less drag mean less power would be required of the new, more efficient engines. Less fuel would be needed, so range and payload could be increased. It's a knee-bone-connected-to-the-ankle-bone concept, and its importance is magnified by the size of these coming giants.

For more on monster transports see the following pages.



In cockpit of new jumbo Lockheed L-1011-500, Pan Am Capt. John Harris briefs author Kocivar on advances that may presage a new class of flying behemoths.

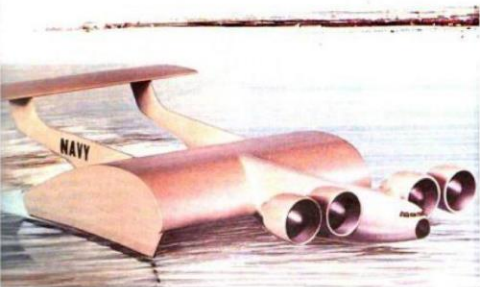
Power-augmented ram Wing-in-ground-effect concept



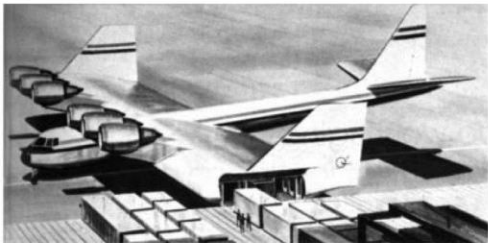


Flat-bed transports could airlift outside military or civilian cargo. This NASA-sponsored Lockheed-Georgia design has a level loading surface close to the ground. Tanks, such as the 118,500-lb. XMI, or other such cargo could roll on and off. In flight, they'd

be lashed down, and hauled exposed. A half-cylinder pressurized module could adapt the transport for passenger or freight operation. Or containerized cargo could be loaded aboard and covered with a thin cocoon to provide aerodynamic fairing.



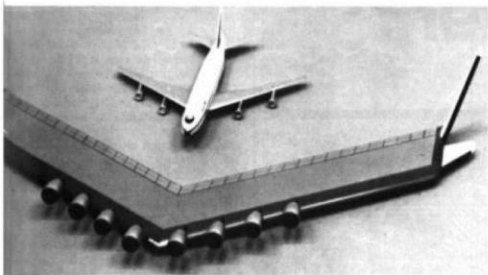
Wing-in-ground-effect transports would use a phenomenon that occurs when a plane flies near the surface: Wings get increased lift from a cushion of high-pressure air trapped beneath, and consequently require less power (see "Ram-Wing X-114," PS, Dec. '77). The ground effect extends to an altitude equal to about half the wingspan. WIGE designs usually have stubby (low aspect ratio) wings for better low-speed control. They're usually seaplanes, since they must fly over fairly flat surfaces with wing-tip end plates skimming the wave tops. These NASA/Lockheed concepts (above and left) would use a power-augmented-ram effect (diagram, left) to shorten takeoff and landing. Engines would tilt up, and exhaust would raise pressure under wing. Speed would be only 400 mph, but payloads could be up to 750,000 lbs.



Spanloaders, with wings 350 to 500 feet long, would carry cargo inside the wings. McDonnell Douglas (top left) and Boeing (left) both have studied this concept. Fully loaded, Boeing's flying-wing design (shown in front of a 747 for comparison) would weigh three million pounds and handle a one million-pound payload.

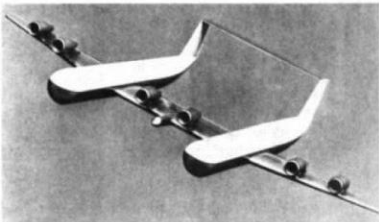
Such monsters would present a problem: Conventional airports do not have runways wide enough or strong enough to handle them. One solution: special hub airports. Smaller aircraft would bring cargo to and from conventional airports to meet the monsters at regional hubs.

Another possible solution: **air-cushion landing gears**. These have already been proved in flight tests with small amphibians and medium-size cargo transports. The air cushion is a large pocket of high-pressure air under the plane, contained in a "trunk" made of some flexible material. When landing or taxiing, air is blown into the trunk, forming a lubricating film so that there is very little ground friction. With the weight of the plane thus distributed over a large area, it could land on water, snow, or soft ground, or land on water and taxi onto a runway of standard strength, as shown (far left). Air pressure is maintained by bleeding air from the engine or a separate on-board fan. The flexible trunk looks like an open-bottom inflatable life raft. When not needed, it would be retracted to fit snugly under the fuselage. The air cushion would replace conventional landing devices—wheel gears, floats, or skis.



Nuclear power would replace petroleum-derived jet fuel in some advance air-transport concepts. A nuclear-powered plane would have almost unlimited range and endurance, but it would not have enough power to take off and land carrying a big payload. One solution: Use an auxiliary power system burning jet fuel for these operations. Another: Use the nuclear-powered plane as a tug only, as in the Lockheed-Georgia concept, above. Without a payload, the nuclear reactor could supply enough power for takeoff and landing. The planes to be towed—the size of today's giant C-5's—would carry the payload, but would carry only enough fuel for takeoff and landing, plus reserves. During cruising flight, they would be towed behind the nuclear tug, like huge gliders, and use no fuel. The nuclear-tug design shown here has a gross weight of about two million pounds; 40 percent would be the reactor. The plane would be a seaplane, and would fly only over water. If it were to fly over land, the design would have to include protection for the reactor in the event of a crash, entailing a heavy weight penalty. The nuclear-powered plane assumes advanced nuclear technology.

Other alternative-energy concepts have been designed by Lockheed for NASA. They include planes that would burn liquid hydrogen, liquid methane, or jet fuel made from coal.



Multibody aircraft, with two or three fuselage sections, would have many structural benefits of the giant spanloaders, but would not require extrawide runways, and thus could land at existing airports. A multibody plane would probably cost more than spanloaders per ton-mile of freight carried, but enough money might be saved by using today's airports to make up the difference. The photo above and our cover painting show two variations of the multibody concept being considered by Lockheed and NASA. The design above has two fuselages attached to a single wing. Six turbine engines are mounted on top of the wing. The tribody concept shown in the cover painting looks like two Lockheed L-1011 Tristars joined at the tails and flanking a large center wing/cargo section. It has engines in the tails as well as under the wings. This tribody design would weigh 1½ million pounds and carry a payload of 441,000 pounds. Half would go in the center fuselage and 25 percent in each outboard fuselage.

Roy Lange, manager of Lockheed-Georgia Company's Advanced Concepts Department, points out an additional advantage of the multibody concept compared with a single large fuselage: Loading and unloading could be done faster. Only limited studies have been done of these two designs, but several twin-body airplanes have flown in the past.

TECHNOLOGY UPDATE



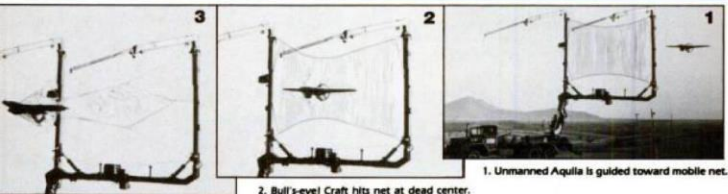
Far-out flying machines for the 21st century

When not building airplanes for the present, engineers at the Lockheed-Georgia Co. like to dream about futuristic concepts for the next century. Some of the far-out ideas they come up with are dillies. Imagine an antisubmarine patrol craft able to remain at sea for days at a time without returning to base. In between reconnaissance missions, the huge amphibious Sea Loiter (upper left) would just park in the water, becoming a floating outpost ready to take to the air at a moment's notice.

The Delta-Wing Spanloader (upper right) is a giant, all-wing cargo transport designed to eliminate the weight and drag of a conventional fuselage. Its airfoil shape, thick

enough to accommodate boxcar-size loads, converts the entire structure into a lifting surface, enabling it to haul 400-ton payloads more than 4,000 miles.

Or take the Flatbed Freighter (lower right). It would carry containerized cargo on its open spine, making loading and unloading much faster and easier than in a cabin plane. Perhaps the strangest concept of all is the Ground-Effect Transport (lower left). A flying boat with cupped wings, it would fly across the ocean only a few feet above the surface without ever getting out of ground effect. Riding a cushion of air, the 238-foot-long water skimmer could carry 220-ton payloads at better than 300 mph.



3. Net stretches to absorb the impact.

2. Bull's-eye! Craft hits net at dead center.

1. Unmanned Aquila is guided toward mobile net.

Gotcha! New aerial snatch saves spy planes

Launching an RPV (Remotely Piloted Vehicle) is easy, but getting it safely back down is another matter. It has no wheels and can't be landed like a conventional airplane. Until recently, such unmanned observation craft were recovered by parachute—a slow method that subjects them to enemy fire and ground impact damage.

The U.S. Army's newest RPV spy plane, the Lockheed-developed Aquila, has no such problems—it's snatched right out of the air on the fly, as shown in the photo sequence above. After a reconnaissance mission, it's guided back to the launch site and flown into a mobile capture rig that looks like a place kicker's net stretched between

football goal posts. The net is designed to give way progressively, slowing the craft and forming a U-shaped sling to cradle it. The sling is then lowered to the ground.

The retractable capture rig, which mounts on a standard five-ton Army truck, can be moved quickly to any location and set up in minutes. The Aquila RPV, fitted with TV cameras and sophisticated surveillance gear, will give the Army a new set of long-range electronic eyes for peering deep into enemy territory.

Editor: Dennis Eskow
Contributors: Sheldon M. Gallager, Jack Hammond,
Michael A. Filon, Phyllis Wolman, John Ginsberg

AVIATION

Biggest planes ever

Huge cargo planes with designs you've never seen before could cut shipping costs by 40 percent, move monster bulldozers from factory directly to strip mines and, adapted for people, let you ride in the same comfortable seat from center city to center city.

Years before the first of these giants takes off, aircraft designers have begun favoring some designs. The two-fuselage freighter shown below, for instance, is now considered more likely to enter production than designs calling for three bodies.

Whatever the final designs, the launching of these planes should be good news for companies with high shipping costs, and ultimately for consumers. Planes envisioned by researchers will carry payloads up to 600,000 pounds, three times that of today's largest cargo planes. Despite a gross weight sometimes exceeding a million pounds,

these planes will fly farther and burn less fuel than today's. They may even be quieter.

These advantages will surface from research to explore composite materials, reduce airstream drag on wings and fuselage, apply advanced electronics and possibly use alternate fuels, such as liquid hydrogen (see *Hydrogen: New Kick for Cargo Planes*, page 118, May '80).

Two versions shown below are on the drawing boards at Lockheed-Georgia. (At NASA's urging, Lockheed, McDonnell-Douglas and Boeing are working on "Very Large Aircraft.")

Lockheed's double-fuselage model will fly a payload of 441,000 pounds at a speed of Mach 0.80 with a range of 4000 nautical miles. Lockheed's advanced concepts department manager, Roy H. Lange, said this version of the big carriers has the best current chance of going into production.

"We also have a triple-fuselage model on the boards," Lange said, but he gave it less chance of flying someday than the two-body carrier. Lange's reasons:

The three-body model would put more stress on the wing. Production would be more efficient if all fuselages were alike. And the proportion of body surface area is higher in the three-body version, creating more drag.

One of Lockheed's more innovative concepts (also below), looking like the toss-away portion of a filleted fish, is called a flatbed design. Its skeletal configuration gives the plane versatility unmatched by other carriers. Modeled after Lockheed's C-141, the flatbed model's payload is 75,000 pounds. Lockheed design engineer Rollo Smethers points out this concept is easily adaptable to much larger planes.

A passenger module that locks onto the flatbed makes the jet look as normal as today's planes. But the clincher, says Smethers, "is the fact that the module could be boarded in midcity, conveyed by rail to the airport, attached to the plane's bed, flown to its destination and sent to midcity by rail again."

How soon will these planes be airborne? "Some time between 1995 and 2000," Lange says. **PM**



Double-fuselage cargo plane will haul 441,000 pounds; flatbed plane (at rear) will adapt for boxcars or passengers.

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CRANK UP YOUR AUTOSOUND SYSTEM

Add-Ons To Get
Big, Full Sound



Магистрант, специалист в области авиации



THE HYDROGEN AGE

As oil dwindles and environmental dangers mount, hydrogen is emerging as a likely candidate to be our power source of the future.

BY ABE DANE,
Science/Technology Editor

AT ONE END of a 3-mile corridor of pavement in the Mojave Desert, a dartlike plane the size of a small jetliner is readied for flight. With only minutes until ignition, a potent slurry of supercooled hydrogen rushes into its fuel tanks. And two pilots monitor an endlessly rehearsed sequence of events that is gradually bringing the craft to life.

The tanks fill. The plane settles on its landing gear, burdened by a load of hydrogen three times its weight. Packing three times the power per pound of Jet-A kerosene, the hydrogen will combust in a row of rectangular ramjet/scramjet engine modules under the rear of the radically swept delta wing. The resulting thrust will propel the plane to 25,000 mph, and fling it into orbit.

The year is 1997. The National Aerospace Plane, the X-30, is on the flight line for the first time. In itself, it is an achievement on the order of the *Apollo* spacecraft. But it also represents a whole family of technologies with the potential to work profound changes on our daily lives.

The tie that binds these technologies together is hydrogen. Today,



Early Lockheed concepts for future freighters provided large fuel storage spaces for lightweight, high-power hydrogen.

even as work goes forward on propulsion systems and new materials for the X-30, quieter advances are being made toward the development of an infrastructure that would bring the fuel of spaceflight home, ending our dependency on dirty and dwindling fossil fuels.

Future fuel

At the heart of hydrogen's promise lie two key qualities. First, supplies of it are virtually limitless. Since it is a primary constituent of water, an economical method of extracting it is the only thing needed to produce literal oceans of energy. Second, burning hydrogen does no harm to the environment. It simply returns the gas to the form of water.

Hydrogen is also a uniquely flexible

medium for the storage and distribution of energy. It is easily converted into electricity through the use of a fuel cell, and electricity can be turned back into hydrogen by electrolyzing water. Transmitted through pipelines similar to those used for natural gas, it can carry energy from large, remote powerplants to individual homes and factories as electricity now does—but with far greater efficiency. And unlike electricity, hydrogen can be kept in tanks to fuel vehicles, or to store power for periods of peak demand.

In the words of Peter Hoffman, editor and publisher of *The Hydrogen Letter*: "Hydrogen is the fuel at the end of the line when everything else has been depleted, found unworkable or environmentally objectionable."

Stumbling blocks

To most people, the word hydrogen immediately conjures up the specter of the *Hindenburg* dirigible, exploding over the New Jersey countryside. Yet, a more objective analysis reveals that hydrogen is no more dangerous than other flammable materials used as fuels, and even has some significant safety advantages. Ironically, a case in point is the *Hindenburg* incident itself. Although it exploded hundreds of feet off the ground, 62 of the air-